DEPARTMENT OF APPLIED STATISTICS
UNIVERSITY COLLEGE, LONDON

Questions of the Day and of the Fray

No. XII

CHARLES DARWIN
1809–1882

AN APPRECIATION

BY

KARL PEARSON, F.R.S.

WITH FRONTISPIECE PORTRAIT
AND PLATE OF NOAH'S ARK

BEING A LECTURE DELIVERED TO THE TEACHERS OF
THE LONDON COUNTY COUNCIL, MARCH 21, 1923

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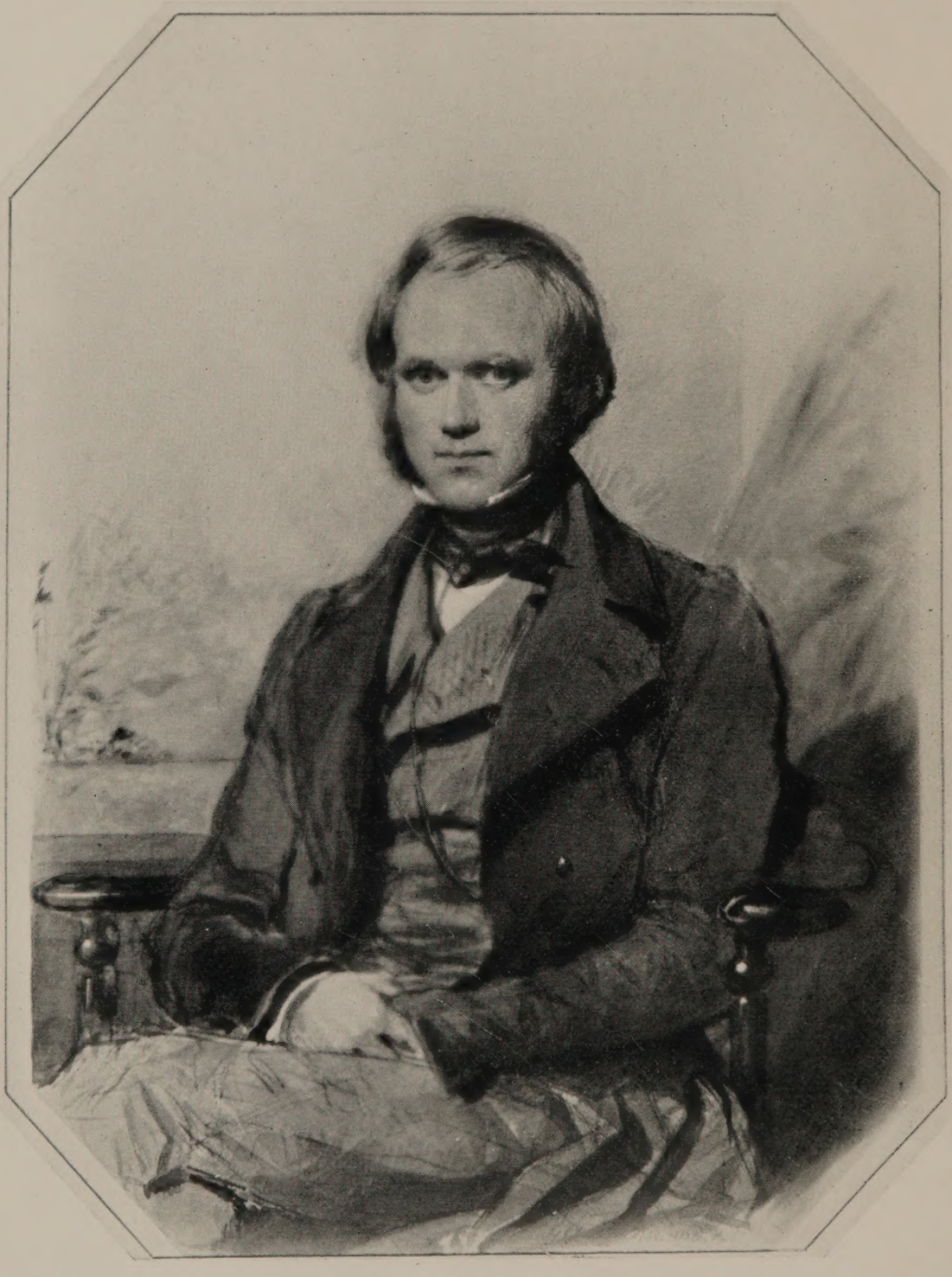

CHARLES DARWIN

AGED 31

From a water-colour painting by
G. Richmond at Burrows Hill.

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SYNOPSIS OF CHARLES DARWIN'S LIFE

CHARLES DARWIN 1809–1882

HEREDITY

DESCENT in four distinct lines from Charlemagne and Alfred the Great through some of the most noteworthy men in European History.

GRANDFATHER: Erasmus Darwin: Fellow of the Royal Society.
FATHER: Robert Waring Darwin: Fellow of the Royal Society.
SUBJECT: Charles Darwin: Fellow of the Royal Society.
SONS: George, Francis, and Horace: Fellows of the Royal Society.
GRANDSON: Charles Galton Darwin: Fellow of the Royal Society.

See Pedigree in "Life of Galton," vol. I.

EDUCATION

1821–1825: *Shrewsbury School.*
"This school as a means of education to me was a simple blank."

1825–1827: *Edinburgh University.*
"The instruction at Edinburgh was altogether by lectures and these were intolerably dull."

1828–1831: *Cambridge University.*
"Three years wasted as far as the academical studies were concerned, as completely as at Edinburgh and at school."

1831–1836: *Voyage on the 'Beagle.'*
"My education really began on board the 'Beagle.'"

1842: Settled at 'Down,' Beckenham, Kent.

LIFE WORK

1836–1844: Geology and reduction of 'Beagle' Zoology.
1844: First definite written shape given to ideas on Evolution.
1844–1856: Collecting and digesting material on Evolution.
1856–1858: Letters to Lyall and Asa Gray on Evolution.
1858: Publication of "Origin of Species by Natural Selection" in conjunction with A. R. Wallace.
1859: Darwin's "Origin of Species."
"He delivered a thought-reversing doctrine to mankind with as little disturbance as possible to the deeply-rooted sentiments of the age." HUXLEY.
1862: "Fertilisation of Orchids."
1864. "Movements and Habits of Climbing Plants."
1868: "Variation of Animals and Plants under Domestication."
1871: "The Descent of Man."
1872: "Expression of the Emotions in Man and Animals."
1875: "Insectivorous Plants."
1879: "Biography of Erasmus Darwin."
1881: "Formation of Vegetable Mould through action of Worms."
1882: Death, April 19th, and Burial, April 26th, in Westminster Abbey.
"I never entered his presence without feeling as a man in the presence of a beloved sovereign. He was so wholly free of petty faults, so royal minded, so helpful and sympathetic. It is a rare privilege to have known such a man, who stands head and shoulders above his contemporaries in the science of observation."
FRANCIS GALTON.

EVOLUTION IN THE ROUGHEST OUTLINE

(See Osborn, *Origin and Evolution of Life*, p. 153)

Millions of years, very rough		Geological Periods and Sub-Periods	Dominant Forms of Life
1	Quaternary	Biblical Creation 4004 B.C.	Age of Man
		Late Pliocene	
		Miocene	
2	Tertiary	Oligocene	Age of Mammals
		Early Eocene	
3		Palaeocene	
4			Extinction of Big Reptiles
5		Cretaceous	Extreme Specialisation of Reptiles
6		Late	
7	Mesozoic		
8		Comanchean	Rise of Flowering Plants
9			
10		Jurassic	Rise of Birds and Flying Reptiles
11		Early	
12		Triassic	Rise of Dinosaurs
13		Permian	Amphibians
14			
15		Upper Carboniferous	Amphibians
16		Late	
17			
18		Lower Carboniferous	Amphibians
19			
20		Devonian	Fishes
21	Palaeozoic	Mid.	
22		Silurian	Fishes
23			
24			
25			
26		Ordovician	Invertebrates
27		Early	
28			
29		Cambrian	Invertebrates
30			

Millions of years, very rough		Geological Periods and Sub-Periods	Dominant Forms of Life
31			
32			
33			
34			
35			
36			
37	Proterozoic		Evolution of Invertebrates
38			
39			
40			
41			
42			
43			
44			
45			Evolution of Unicellular Life
46			
47			
48			
49			
50			
51	Archaean		
52			
53			
54			
55			
56			
57			
58			
59			
60			

EVOLUTION IN THE ROUGHEST OUTLINE

Tenfold Enlargement of Tertiary and Quaternary Times

100,000 of years, very rough		Geological periods	Types of life	
1	Quaternary	Holocene	Men of Iron, Bronze and Neolithic Ages to 10,000 B.C. Biblical creation 4004 B.C.	
2		Post Glacial	Palaeolithic Man	Age of Man
3			Extinction of Great Mammals	
4		Pleistocene	Palaeolithic Man	
5		Glacial	'Eolithic' Man	
6	Tertiary		*Pithecanthropus*	Age of Mammals
7		Pliocene	and	
8			Transition to Man	
9		Late		
10		Miocene	Culmination	
11			of Mammals	
12				
13				
14		Oligocene	Beginnings	
15			of	
16			Anthropoid Life	
17				
18				
19				
20		Eocene	Rise of Higher	
21		Early	Mammalian	
22			Types	
23				
24				
25				Age
26				
27		Palaeocene		
28				
29				
30				
3,000,000 years			Extinction of big Reptiles	

YOU ask me what is the ultimate purpose of this story of life?—Does the real connoisseur seek the ultimate purpose of a great composition, or is he not content to study and enjoy it, and this even when the artist is unknown to him? Let those go further who have more knowledge, more wisdom in applying it, and more confidence that man's intellect has reached a stage where it can answer profitably such questionings.

CHARLES DARWIN, 1809–1882

WHEN I accepted an invitation through Sir Robert Blair to lecture to you on one of the "Master Minds of Science" fully six months ago, I did not clearly realise how difficult my task was likely to be. He had asked me to give my discourse on Galileo Galilei, and there indeed was a "master mind" as I understand one. I would define a "master mind" as one who produces a revolution in current thought,—not only in scientific thought, but in the repercussion of science on human thought generally. Galilei was certainly such a master mind; and those of us who were born in mid-Victorian days have seen at least two others in the flesh, Charles Darwin and Einstein. It may seem strange at first that a mathematician should ask to take Charles Darwin rather than Galilei, for his discourse, but Darwin has lived close enough to us to measure faithfully his personality. Yet he is far enough from us for us to judge fairly the magnitude of his work, and your present lecturer is old enough to tell you at least something of the freedom of thought which Darwin won for the men of his own generation. The fact that I am not a professed biologist might reduce the value of any judgment I might give you of what Darwin achieved in the narrower fields of specialised investigation. But to enter into those matters would require not one lecture but a course, and not one lecturer, but half-a-dozen specialists.

What was the great reversal of thought which Darwin wrought? What great truth did he bring home to you and to me—to the men in the street as apart from a relatively small group of specialised scientists? That limited aspect of Darwin's work must be my chief theme in the brief time at my disposal tonight. Try and grasp what a reversal of thought means to mankind at large. Intelligent man does not merely live and strive to extract pleasure from the universe around him. He searches for some account of that universe and his own existence in it. All living forms have developed for good or evil *curiosity*, and man among his curious next of kin, the apes, is, perhaps, the most inquisitive primate. His success has largely depended on his curiosity. If he can

satisfy his curiosity by knowledge, well and good; but if he cannot, he will not consent to await experiment and observation; he fills up the aching void of his ignorance by hypothesis, by imagination based upon general impressions or limited experience often of a very slender character. Ever since so-called civilisation started, men of every race and of every country have built up cosmogonies to explain how the universe came about and how man came to be part of it. The Eskimo, the Zulu, the Hindoo, the Red Indian, the Egyptian and the Jew have each had their own separate cosmogonies, and these beliefs have played no little part in the development of those races. A false cosmogony may aid a race in a deadly struggle, or by want of elasticity may strangle it. Even today every nation has its tribal god.

Now general impressions, or conclusions not based on trained observation and experience are never to be trusted. Unfortunately man is still close to his childhood, and thus his curiosity, if great, is yet easily satisfied like that of a child. Man's temptation is to think of a thing once, and then to accept the explanation given to him by authority. That explanation becomes a basis for his conduct in life, and he looks with distaste if not with hatred on any one who submits his philosophy of life to questioning. It involves a readjustment of his thought and very likely a readjustment of his rules of conduct, and to think all these things out afresh requires a strong intellectual effort, and even some of the best of us will shirk that. The "reversal of thought" is too severe a task for us; if old and wise, we are prepared to admit the new truth even if we cannot understand it; if old and foolish we express horror and hatred for it, because we will not admit that our mind has grown too rusty to reverse its thought. Here comes in the glory of the young, their impressions are not prescriptive truths; their minds are not too rusty to reverse their thought. Some of you may well realise the tremendous task which is falling to your lot in revising your views on the universe so that they may accord with the doctrine of relativity. Those who have attempted it know that it means not only a reconstruction of their ideas of the physical universe, but even of their philosophy of life, and possibly of their religious views. Well, what your generation may feel with regard to Einstein, the mid-Victorians felt with regard to Darwin, and at a much earlier date men from one end of Europe to the

other felt, when Copernicus and Galilei destroyed the geocentric legend of the Universe. The Church thundered; men imagined their whole creed of life tottering, the sacred impressions of Heaven, Earth and Hell as they had held them from childhood, as Dante and Milton had pictured them were assailed; the old could not reverse their thought; the young *did*, and within half-a-century the earth was accepted as an insignificant planet of a by no means important star.

It was a similar shattering blow which Darwin struck in 1859 at the anthropocentric conception of life. The old felt their intellectual universe totter, and their anger rose against the man who would force them to a reconstruction of their ideas, to a reversal of their thought. And yet as Huxley has put it: "Darwin delivered a thought-reversing doctrine to mankind, with as little disturbance as possible of the deeply-rooted sentiments of the age"[1].

What made Huxley express himself thus? George Fox produced a reversal of thought in thousands and Martin Luther in hundreds of thousands, and yet Huxley's lines would not apply to them. They were desperately earnest men as Darwin was earnest, but they were fanatical in that they struck to wound. Darwin never struck to wound. He was absolutely free of all personal bitterness. Those who knew him intimately all speak alike of the extraordinary charm of his character.

Listen again to what Huxley wrote of him:

> There are many to whom Mr Darwin's death is a wholly irreparable loss. And this not merely because of his wonderfully genial, simple and generous nature, his cheerful and animated conversation, and the infinite variety and accuracy of his information; but because the more one knew of him, the more he seemed the incorporated ideal of a man of science. Acute as were his reasoning powers, vast as was his knowledge, marvellous as was his tenacious industry, under physical difficulties which would have converted nine men out of ten into aimless invalids: it was not these qualities, great as they were, which impressed those who were admitted to his intimacy with involuntary veneration, but a certain intense and almost passionate honesty, by which all his thoughts and actions were irradiated, as by a central fire. It was this rarest and greatest of endowments which kept his vivid imagination and great speculative powers within due bounds; which compelled him to undertake the prodigious labours of original investigation and of reading, upon which his published works are based; which made him accept criticisms and suggestions from anybody and everybody, not only

[1] *Nature*, XXVI, 99.

without impatience, but with expressions of gratitude sometimes almost comically in excess of their value; which led him to allow neither himself or others to be deceived by phrases, and to spare neither time nor pains in order to obtain clear and distinct ideas upon every topic with which he occupied himself.

One could not converse with Darwin without being reminded of Socrates. There was the same desire to find some one wiser than himself; the same belief in the sovereignty of reason; the same ready humour; the same sympathetic interest in all the ways and works of men.

And again:

None have fought better, and none have been more fortunate than Charles Darwin. He found a great truth, trodden underfoot, reviled by bigots, and ridiculed by all the world; he lived long enough to see it, chiefly by his own efforts, irrefragably established in science, inseparably incorporated with the common thoughts of men, and only hated and feared by those who would revile, but dare not. What shall a man desire more than this?[1]

Or again, read what Francis Galton wrote to his sister two days after Darwin's death:

Dearest Emma, I feel at times quite sickened at the loss of Charles Darwin. I owed more to him than to any man living or dead; and I never entered his presence without feeling as a man in the presence of a beloved sovereign. He was so wholly free of petty faults, so royal minded, so helpful and sympathetic. It is a rare privilege to have known such a man, who stands head and shoulders above his contemporaries in the science of observation....I hope the first wishes of the family may yield and that Charles Darwin may be laid by the side of Newton as the two greatest of Englishmen of science....The world seems so blank to me now that Charles Darwin is gone. I reverenced and loved him thoroughly[2].

And once more Galton spoke of Darwin at the Royal Society Anniversary Dinner, four years later[3]:

Few can have been more profoundly influenced than I was by his publications. They enlarged the horizon of my ideas. I drew from them the breath of a fuller scientific life, and I owe more of my later scientific impulses to the influences of Charles Darwin than I can easily express. I rarely approached his genial presence without an almost overwhelming sense of devotion and reverence, and I valued his encouragement and approbation more, perhaps, than that of the whole world beside.

Or take this letter of Charles Kingsley to Sir John Lubbock, May 27, 1867[4]:

I was deeply moved at meeting, for the first time, Darwin. I trembled before him like a boy, and longed to tell him all I felt for him, but dare not, lest he should think me a flatterer extravagant.

[1] *Nature*, XXV, 597.
[2] *Life of Galton*, II, 198.
[3] *The Times*, Dec. 1, 1886.
[4] Hutchinson's *Life of Sir John Lubbock*, I, 92.

But the modesty and simplicity of his genius were charming. Instead of teaching he only wanted to learn, instead of talking, to listen, till I found him asking me to write papers which he could as yet hardly write himself—ignorant in his general simplicity of my ignorance, and his own wisdom. And yet of that man Owen said to me—"Darwin is just as good a soul as his grandfather and just as great a goose."

Such statements might be largely multiplied, but I will give one more only, that of the celebrated botanist De Candolle, the younger, who visited Darwin eighteen months before his death in the autumn of 1880:

I remarked that Darwin in the seventies was more animated and appeared happier than when I had seen him forty-one years before. His eyes were keen and his expression lively while his photographs shew that his shape of head is rather that of a philosopher of antiquity. His talk, varied, frank and winning, entirely that of the gentleman, reminded me of that of the Oxford and Cambridge scholars. His general tone accorded with that of his writings, and this tone is the stamp of that sincerity which every one recognises as one of the causes of Darwin's success.

To the foreigner De Candolle, to his countryman Huxley and to his cousin Francis Galton, the foremost idea which personal contact with Darwin conveyed was not transcending intellect, but sincerity and simplicity of character. It was this graciousness of character, that even the outside world rapidly came to realise, which was a great factor in the victory which Darwin achieved. It was the chief reason why his thought-reversing doctrines made the minimum of disturbance in the deeply-rooted sentiments of his age. Personal character made the battle infinitely easier than it would have been had Darwin combined the highest powers of mind with truculence and self-assertion. He was so deeply hurt by these characteristics in certain of his opponents, like Wilberforce and Mivart, that he left controversy largely to others, and opposed it only with fuller collections of facts and observations.

Now we have seen that the work of Copernicus and Galilei was the destruction of the geocentric cosmogony. The work of Darwin was the destruction of another neolithic myth, the anthropocentric doctrine of living forms; it was hard to believe that the immeasurable universe had been created for man, when we recognised the insignificance of his earth and his sun. It was still harder to hold that all living forms had been independently created, to be subservient to a special creation, Man, after the work of Charles Darwin. It may be true that Man, physically by his tools, and mentally by his

brain development does dominate all other living forms at this epoch. But he would be a rash man who would venture to assert that his ancestry has always done so; and only a still rasher man would venture to predict that anything we should class as man will continue to dominate all life for aeons to come. An intelligent reptile in the age of reptiles might easily have scoffed at the forecast of an inconceivable form of life, a mammal, bruising his head; and can we even assert that among mammals Man is the last word of creative evolution?

Put yourself psychologically in the position of the savages on a Pacific Island. They were men who dominated other forms of life within their ken, and they were surrounded by an impassable element, a void which they might venture on but could not cross. No man was able to grasp what was beyond its bounds. And then came a white being from nowhere, on a moving island, able to destroy the savage from a distance, utterly and wholly dominating him;—utterly and wholly unexpected and beyond his mental forecast. Always remember that there may be forms of life as unintelligible to us, and yet equally able to cross our void. I am not making a forecast, I am merely suggesting that it is not wholly wise to assume that the evolution of life has reached its highest and final form in man on this earth, and that evolution must end with the age of mammals and with man dominating living forms in his small corner of the cosmos.

Well, Darwin broke down this primitive belief that man for all the past had and for all the future would dominate life, the anthropocentric myth. But to understand the relief brought by Darwin to the minds of his generation, we must look into the state of affairs in his time, and see why the season was ripe for the arrival of a Darwin.

I do not know whether you remember what the first words in most English translations of the Bible are or were? They run B.C. 4004. That is the date fixed for the creation of the world by the Church. According to that view the universe and all its types of life were created about 6000 years ago. That is about the time of the 1st Egyptian Dynasty, which marked a fairly developed civilisation, at least two thousand years later than the neolithic woman from Egypt in our Laboratory Museum, perhaps a hundred thousand years later than the first appearance of palaeolithic man. You will say, and rightly say, that nobody now pays any attention to

the dates down the margin of the Bible; they are not part of the original scriptures and may be disregarded. Quite so, nobody *now* pays any attention to the church's old dogma that the sun moved round the earth, but they did pay attention to it and had to pay attention to it, until Copernicus and Galilei controverted it. If we have ceased to believe that the world and all its forms of life were created in 4004 B.C. it is because Darwin freed us from that cramping doctrine. I must give you a little historical account of what men believed before Darwin. I can only sketch in broad lines certain features of human belief. I take first John Woodward, born in 1665—died in 1728, the founder of the Woodwardian Professorship and Geological Museum at Cambridge, and a Fellow of the Royal Society. He was one of the early collectors of fossils and he was struck by the great variety of sea shells and other marine products to be found incorporated in the stone of the quarries he visited all over the country. But for that B.C. 4004 he might have groped his way towards great geological truths; as it was he recollected the history of the flood B.C. 2000, and wrote an "Essay towards a natural history of the Earth and terrestrial bodies, especially minerals ....With an account of the universal deluge, and of the effects it had on the earth," 1695. In this essay he asserts that the flood turned all the solid rocks of the earth into mud, and that this mud was gradually redeposited with the débris of the animals drowned in the flood. Dr Arbuthnot wrote a criticism of this deluge theory; he criticised it not only from the standpoint of the physics of rock and mud, but also from the Biblical story, because if the surface of the earth were covered by mud, and all its strata reduced to a plastic condition, how was it possible that the old rivers should reappear after the deluge? Why as we are told in Genesis, Chapter II, did the pre-diluvial rivers and pre-diluvial countries reappear in post-diluvial times? Thus Arbuthnot cited Moses to confute Moses. It is needless here to cite various hypotheses to account for the existence of fossils in the lower strata of rock masses. In the 18th century some thought they had been placed there at the creation itself; others believed that the Devil inserted them to tempt man. With a complete history of the world supposed known from its creation in 4004 B.C. no real solution was possible.

Before Darwin there were two great naturalists Linnaeus 1707–1778, and Buffon born in the same year as Linnaeus

and dying in 1788, twenty years before the birth of Darwin. Huxley writes of these two that they are the only naturalists comparable with Darwin. Yet Linnaeus directly talks of the separate creation of the various forms of life. In his great work *Systema naturae* he defines man as the ultimate purpose of creation. He is cramped as much as Woodward by that B.C. 4004. If we turn to the more free-thinking and more free-acting Buffon do we find that he has thrown off the fetters? No, he is still bound by them. It is perfectly true that Buffon does not accept such explanations as that the fossil shells were dropped by pilgrims or by armies crossing the Alps. He does ask whether the fossil bones of apes were those of apes who carried the shells hundreds of miles inland! The discovery of marine fossils hundreds of miles inland was partially opening men's minds to the immensely long history of the earth. But Buffon had no explanation ready for this enormous variety of life, and his mind like so many of our minds was built in water-tight compartments. He recognised that the span of man's life was now and had been in the time of David three-score years and ten. But he felt it essential to reconcile this with the biblical information as to the age of some of the patriarchs. He tells us that the chief source of death in man is the hardening of the tissues, so that they cannot restore themselves. When the world was young gravity had not condensed its materials, everything was more plastic, and all substances were softer. Hence it came about that they did not harden so rapidly. The tissues of Methuselah remained softer longer than those of modern man, and therefore he lived longer! Thus for Buffon the world was young in 3150 B.C. He had not freed himself once and for all from the neolithic myth.

But the mind of man was growing restless in its bondage to this myth. It was not only the mass of fossils in solid rock, which could not be explained by any deluge, but must have taken millions of years to lay down; it was also the study of the classification of living forms which began to make men doubt a single creation of separate species. Erasmus Darwin (1794), Charles' grandfather, was convinced that species vary and that life was deduced from some simple original, but he could not attribute the changes to anything but the inheritance of acquired characters. The individual was continually striving and *willing* to achieve something, attempting to fit itself into an unoccupied corner of nature,

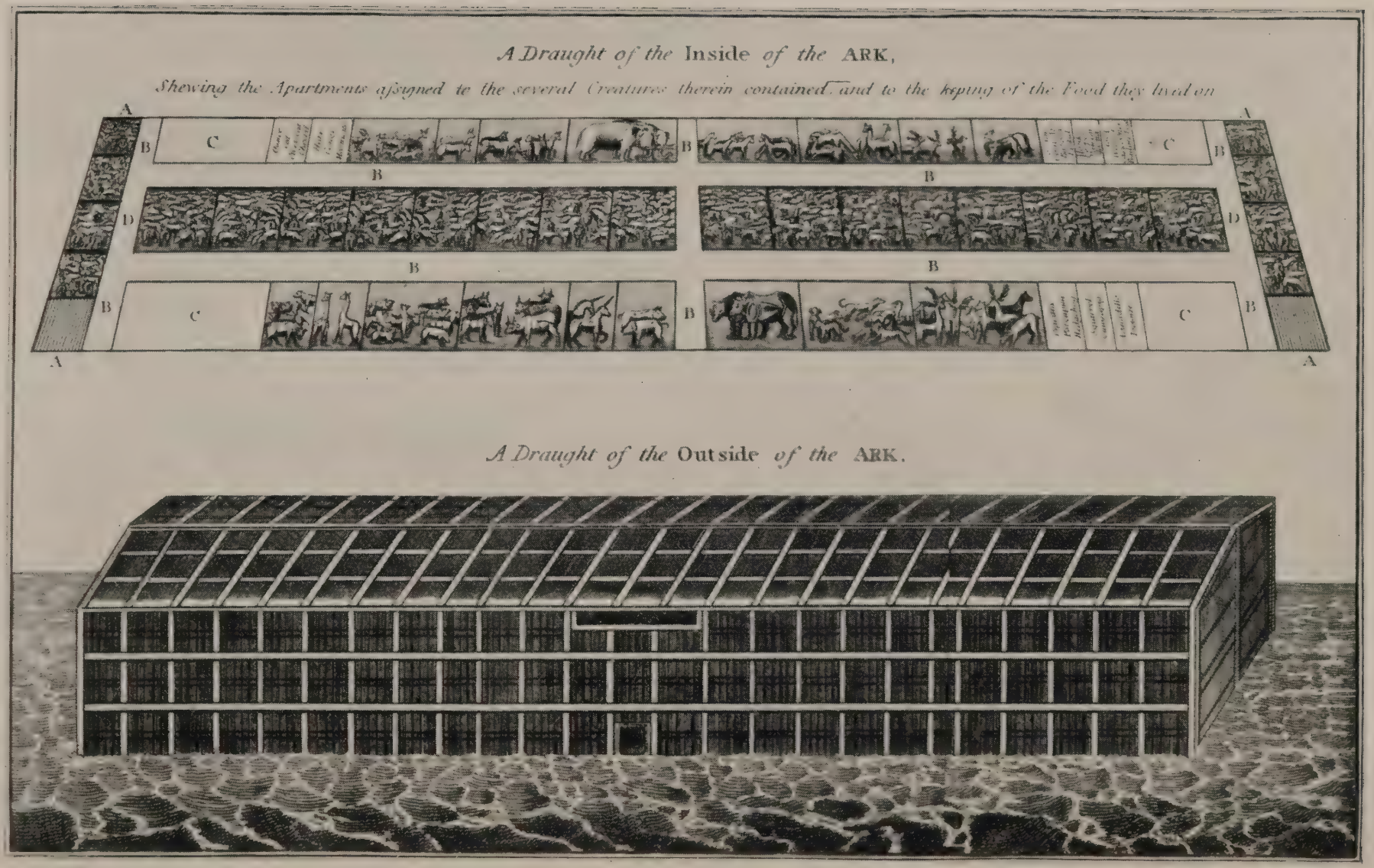

Plate from a work published by the Clarendon Press, Oxford, in 1801 entitled: *Historical Geography of the Old and New Testament.* The author, Dr Edward Wells, demonstrates in Chapter II, that the dimensions attributed to Noah's Ark were amply sufficient to contain seven individuals of all clean and two individuals of all unclean beasts together with the requisite supply of hay (369,562·5 cubic feet) and of sheep (1888 head) for their food.

and its offspring inherited the modifications the parents had produced in their organs or habits. Lamarck following Erasmus Darwin—probably unconsciously—was a naturalist with a far wider knowledge of living forms, and was able to make out a stronger case for evolution, which he published in the year of Darwin's birth 1809. But his explanation of evolution was as unsatisfactory as Erasmus Darwin's; forms of life *willed* to be other than they were, they then became other and transmitted their modifications to their descendants. The views of Erasmus Darwin and Lamarck have been advocated later by Samuel Butler and Bernard Shaw, but the discussions of these moderns are of little value as they have small if any acquaintance with the immense mass of material which Darwin's theory at once codified. Lamarck and Erasmus Darwin are chiefly of value as indicating how science was struggling before Charles Darwin against the bondage of a special creation.

But that bondage was not broken by the evolutionists before Charles Darwin[1]. Erasmus Darwin was branded as an infidel by more than one writer of his generation. Lamarck died in 1829 a disappointed man, whose views on evolution had been destroyed by Cuvier (1769–1832), who insisted on the permanence of species, and reconciled this with palaeontological evidence by asserting that the earth had been subject to a series of cataclysms which enabled its Creator to produce afresh new series of living forms. Cuvier would save creation by replacing one creation by a number of successive creations. Thus he forged anew the chains which cramped the mind of man.

You may suggest that while science had not solved the problem of evolution, it had at least thrown off the belief in B.C. 4004. I do not think, if you study the writings of men of even great ability between 1850 and 1860 you will press your suggestion. I will take two out of many instances I could cite. Francis Galton had a mind far above the average. In 1854, in addition to many years of academic study, he had travelled widely, and seen men of many races. Well, Galton talks in his *Art of Travel* of the use of fire-sticks, and he says:

> The method of obtaining fire by rubbing sticks together was at one time nearly universal. It seems remarkable that the time of discovery of the art of fire-making is not recorded in the Bible. We may easily imagine that our first parents obtained their fires

[1] The accompanying plate indicates what mankind took seriously in the first quarter of the nineteenth century.

from natural sources; of which, some parts of the Caucasus at least, abound in examples. But when Cain was sent an outcast, how did *he* obtain fire? It is remarkable that his descendants are precisely those who invented metallurgy, and arts requiring fire. We might almost theorize to the effect that he or they discovered the art of fire-making, and pushed the discovery into its applications.

Do you grasp now what I mean when I speak of that bondage of 4004 B.C.? We are fairly certain now that the art of fire-making was known 40,000 years ago, possibly 100,000. How could man envisage his own history with that dead weight on his mind?

Now take another case, that of Speke the great African traveller writing on Africa in the very early sixties. He writes thus of the negroes:

> If my account should not harmonise with preconceived notions as to primitive races, I cannot help it. I profess accurately to describe naked Africa—Africa in those places where it has not received the slightest impulse, whether for good or for evil, from European civilisation. If the picture be a dark one, we should, when contemplating these sons of Noah, try and carry our mind back to that time when our poor elder brother Ham was cursed by his father and condemned to be the slave of both Shem and Japheth; for as they were then, so they appear to be now—a striking existing proof of the Holy Scriptures. But one thing must be remembered; whilst the people of Europe and Asia were blessed by communion with God through the medium of His prophets, and obtained divine laws to regulate their ways and keep them in mind of Him who made them, the Africans were excluded from this dispensation, and consequently have no idea of an overruling Providence or a future state; they therefore trust to luck and to charms, and think only of self-preservation in this world[1].

We know now that the negro existed many tens of thousands of years before the date assigned to Ham! How could there be any anthropology, any real study of man's origin and development under such bondage?

I will give you one more illustration of how these Mosaic fetters ate into and cankered the very spirit of scientific investigation[2]. We have seen what difficulties the discovery of fossils caused Woodward and Arbuthnot. An equal diffi-

[1] *Discovery of the Sources of the Nile*, Introduction, p. i.

[2] If the reader desires further evidence of such fetters—as late as 1845—let him consult the *Geschichte der Urwelt mit besonderer Berücksichtigung der Menschenrassen und des Mosaischen Schöpfungsberichtes*. The author, Dr Andreas Wagner, was a member of the Bavarian Royal Academy of Sciences and Professor of Zoology in Munich. He finds in science, physical and organic, and in revealed religion, creation, flood and descent from Noah, no contradictions whatever.

culty arose when not only fossils were found, but the artefacts, the tools men had made and used tens of thousands of years ago.

As late as 1860 Lartet presented to the French Academy of Sciences a memoir entitled: "On the geological antiquity of the human race in Western Europe"; it was an epoch-making memoir, but *that Academy printed only the title of it.* As Cartailhac notes it was too early to speak such truths to the Academy of Sciences; it did not comprehend that it placed itself on the very outskirts of progress in geology and anthropology by such an action. Three years later the Perpetual Secretary of the Academy, Elie de Beaumont, ventured to say that he did not believe that man had been a contemporary of the mammoth; that the view of Cuvier—i.e. the theory of repeated re-creations after cataclysms—was the product of genius, and it had not been destroyed. He asked if flint tools were not really of Roman origin!

Nay, even ten years later in 1872 the French Academy of Sciences declined to elect Charles Darwin to its zoological section, and an eminent member of the Academy wrote to *Les Mondes*

> What has closed the doors of the Academy to Mr Darwin is that the science of those of his books which have made his chief title to fame—the *Origin of Species* and the *Descent of Man*—is not science, but a mass of assertions and absolutely gratuitous hypotheses, often evidently fallacious. This kind of publication and these theories are a bad example, which a body that respects itself cannot encourage.

Darwin was twenty-five years collecting and digesting material for those books; no books written before or since have placed before their readers such a mass of well-correlated facts and observations. Yet both are here dismissed as a mere "mass of assertions and absolutely gratuitous hypotheses" as if they had been the product of a sensation-monger—not an indefatigable worker and cautious thinker like Charles Darwin.

Let us conclude this section of our discourse by citing a few words spoken in Manchester in 1901 by John Morley—now Lord Morley—they show that not only the theologians, not only the high priests of science in France, but the great men of politics failed to understand how Darwin had broken the fetters of men's minds:

> "I remember," Mr Morley said, "once going with Mr Gladstone one Sunday afternoon to pay a visit to Mr Darwin. It was in the

seventies. As I came away I felt that no impression had reached him that in that modest, single-minded, low-browed lover of truth, that searcher of the secrets of Nature—that there was no impression in Mr Gladstone's mind that he had seen one who from his Kentish hill-top was shaking the world."

Such was the shadow that the spirit behind those figures —4004 B.C.—cast across the world of thought!

I am young enough to have escaped the dogmatic teaching which was impressed upon the pre-Darwinian child. But I am not sure it has come to an end even yet. Not so many years ago in a village in Southern Germany the priest with whom I had become intimate in our evening talks in the village inn asked me, if I would like to listen to his lesson in the village school. I readily consented and this is what I heard, starting with his opening words:

Der Geistliche: Wer war der erste Mann?
Die Kinder (a hundred and fifty simultaneously): **Adam.**
Der Geistliche: Wer war das erste Weib?
Die Kinder (a hundred and fifty simultaneously): **Eva.**
Der Gestliche: Zu welcher Zeit war die Welt erschaffen?
Die Kinder (a hundred and fifty simultaneously): **Viertusend und vier Jahre vor Christi.**

Now can you grasp what that means? It means that the astonishing history of life in the world, the glorious story of man's own evolution lasting for far more than 100,000 years has been cut off at its topmost branches. And the result is not only the hopeless fogging of the child's perspective. There is a worse side to it. This legend created, perhaps, 6000 years ago—a mere yesterday in the life of man—has been unfortunately attached to the child's instruction in morals. Thus when he finds later in life that the legend has no relation to our real knowledge of man's past, he is liable not unnaturally, if unreasonably, to discard both.

I have said I am too young,—or perhaps I ought to have said too fortunate in my parentage,—to have been forced under that dogmatic yoke. But let us see what men, who had been, felt about Darwin's teaching.

Let me read to you a letter of Francis Galton to Darwin dated 1869, when Darwin had been reading Galton's *Hereditary Genius*.

Dec. 24, 1869.

My dear Darwin, It would be idle to speak of the delight your letter has given me for there is no one in the world whose approbation in these matters can have the same wieght as yours. Neither

is there any one whose approbation I prize more highly on purely personal grounds, because I always think of you in the same way as converts from barbarism think of the teacher who first relieved them from the burden of their superstition. I used to be wretched under the weight of the old fashioned 'argument from design' of which I felt though I was unable to prove to myself the worthlessness. Consequently the appearance of your "Origin of Species" formed a real crisis in my life; your book drove away the constraint of my old superstition as if it had been a nightmare and was the first to give me freedom of thought.

And again at the Darwin-Wallace celebration in 1908, Galton turned to the main point on which he felt our generation's gratitude to Darwin should be keenest—the freedom Darwin gave us from dogmatic bondage:

You have listened to-day to many speakers and I have little new to say, little indeed that would not be a repetition, but I may add that this occasion has called forth vividly my recollection of the feelings of gratitude that I had towards the originators of the then new doctrine which burst the enthraldom of the intellect which the advocates of the argument from design had woven round us. It gave a sense of freedom to all the people who were thinking of these matters, and that sense of freedom was very real and very vivid at the time. If a future Auguste Comte arises who makes a calendar in which the days are devoted to the memory of those who have been the beneficent intellects of mankind, I feel sure that this day, the 1st of July, will not be the least brilliant[1].

I have already indicated that there were keen evolutionists before Darwin but none of them had propounded any reasonable theory of how evolution takes place, still less had they exhibited any correlated system of facts as flowing from their theories. Let us read what Huxley wrote about the matter, for he had felt the pulse of the chief scientists of his generation:

I imagine that most of those of my contemporaries who thought seriously about the matter, were very much in my own state of mind—inclined to say to both Mosaists and Evolutionists, "a plague on both your houses!" and disposed to turn aside from an interminable and apparently fruitless discussion, to labour in the fertile fields of ascertainable fact. And I may, therefore, further suppose that the publication of the Darwin and Wallace papers in 1858, and still more that of the "Origin" in 1859, had the effect on them of the flash of light, which to a man who has lost himself in a dark night, suddenly reveals a road which, whether it takes him straight home or not, certainly goes his way. That which we were looking for, and could not find, was a hypothesis respecting the origin of known organic forms, which assumed the operation of no causes but such as could be proved to be actually at work. We wanted not to pin our faith to that or any other speculation, but

[1] *The Darwin-Wallace Celebration...by the Linnean Society of London*, 1908, pp. 25–6.

to get hold of clear and definite conceptions which could be brought face to face with facts and have their validity tested. The "Origin" provided us with the working hypothesis we sought. Moreover it did the immense service of freeing us for ever from the dilemma—refuse to accept the creation hypothesis and what have you to propose that can be accepted by any cautious reasoner? In 1857, I had no answer ready, and I do not think any one else had. A year later, we reproached ourselves with dulness for being perplexed by such an inquiry. My reflection, when I first made myself master of the central idea of the "Origin" was, "How extremely stupid not to have thought of that!"[1].

Therein you see the master mind as exhibited by Darwin. He realised that his time was sick of vague hypotheses whether creational or evolutional, and he gave them a theory which at least correlated a multitude of facts,—a theory by the light of which men have found it possible to work fertilely for fifty and more years; a theory which created embryology and anthropology, and which simply caused geology, palaeontology, botany and zoology to be rewritten. Call "natural selection" a working hypothesis, if you please, and you will still find it is the source of all the best work in the science of life for more than half a century. But is not all scientific advance made by the launching by master minds of "working hypotheses"? What else was the law of gravitation as propounded by Newton? He no more explained why things gravitated than Darwin explained why individuals vary. And although the law of gravitation fructified physical science for more than 100 years, we know it is not absolutely the whole truth and now start with a wider "working hypothesis." If we said that of natural selection, we should not in the least detract from the services of Charles Darwin; his would still remain a master mind, worthy to be placed in life as in death alongside Newton's. But if we said that the day of natural selection is passed should we be speaking the truth? We should at least be echoing the cry of some dozens of smaller minds, who declare that natural selection is wanting and give nothing in its place. That is not the line on which the great steps in science have been made. The giant has reached further to the summit, because he stood on the shoulders of the great of the past[2]. Natural selection will cease to be a part of the scientific creed only when a wider working hypothesis

[1] *Life and Letters of Charles Darwin*, II, 196–7.

[2] "If I have seen further, it is by standing on the shoulders of giants," *Newton's Letter to Hooke*, Feb. 5, 1675–6.

is discovered by another master mind, and there is no sign among the biologists of our generation of a greater than Darwin. Their work has been the steady, necessary, if unsensational task of reaping where Darwin sowed, and the harvest is still after 60 years incompletely garnered.

If you read the chapter in Sir Francis Darwin's *Life and Letters of Charles Darwin* which is entitled "Religion," you will understand how carefully Darwin really thought over these matters, although he was reticent with regard to them, and very modest as to the results of his thoughts on religious and moral topics. But he recognised fully that the belief in a creation and flood some few thousand years ago was an intolerable bondage for human thought. He felt also, as Huxley felt and Galton felt, that the argument from design, even if applied to the variations on which evolution was based, was very fallacious.

If some variations seem beautifully adapted to their use, it was impossible to assert this as a general truth. Was it, he asked, direct purpose which caused the frame and mental qualities of a dog to vary so that a breed could be formed of indomitable ferocity, with jaws fitted to pin down the bull for man's brutal sport?[1] He might have cited also the delicate apparatus of the parasite, which enables it to fix itself firmly in the intestines of its host.

Writing his autobiography in 1876 Darwin says[2]:

> Although I did not think much about the existence of a personal God until a considerably later period of my life [later than the 'Beagle' voyage, 1836–39, when he discarded the Old Testament as a revelation] I will give the vague conclusions to which I have been driven. The old argument from design in Nature, as given by Paley, which formerly seemed to me so conclusive, fails, now that the law of natural selection has been discovered. We can no longer argue that, for instance, the beautiful hinge of a bivalve-shell must have been made by an intelligent being, like the hinge of a door by man. There seems to be no more design in the variability of organic beings, and in the action of natural selection, than in the course which the wind blows.

Pain and suffering have been looked upon as instruments designed for man's moral improvement, but other sentient beings suffer without any moral improvement[3]. These things Darwin held were compatible with the view that all organic

[1] *Animals and Plants under Domestication*, II, 427.
[2] *Life and Letters*, I, 309.
[3] *Ibid.* 311.

beings have been developed through variation and natural selection, but not with an anthropocentric universe created for man by an intelligent and just First Cause.

Some of you will remember the wonderful paragraph with which the *Origin of Species* closes. I cannot refrain from citing it again here:

It is interesting to contemplate a tangled bank, clothed with many plants of many kinds, with birds singing on the bushes, with various insects flitting about, and with worms crawling through the damp earth, and to reflect that these elaborately constructed forms, so different from each other, and dependent upon each other in so complex a manner, have all been produced by laws acting among us. These laws, taken in the largest sense, being Growth with Reproduction; Inheritance which is almost implied by reproduction; Variability from the indirect and direct action of the conditions of life, and from use and disuse; a Ratio of Increase so high as to lead to a Struggle for Life, and as a consequence to Natural Selection, entailing Divergence of Character and the Extinction of less-improved forms. This, from the war of Nature, from famine and death, the most exalted object which we are capable of conceiving, namely, the production of the higher animals, directly follows. There is grandeur in this view of life, with its several powers, having been originally breathed by a Creator into a few forms or into one; and that, whilst this planet has gone cycling on according to the fixed law of gravity, from so simple a beginning endless forms most beautiful and most wonderful have been, and are being evolved[1].

This passage is of very great value for (i) it indicates how the commonest objects of our experience—the population of a hedge-row—have since the doctrine of Darwin become replete with the most intensely suggestive problems connected not only with our views of life, but with our religious notions; (ii) the passage is Darwin's own summary of Darwinism, and as Huxley put it in a letter to Galton of 1883, in our possession in this laboratory:

Which Faith except a man do keep whole and undefiled, without doubt he shall be made a bishop.

(iii) It indicates that in 1859 Darwin still looked to a First Cause having an intelligent mind in some degree analogous to that of man. He says himself[2]:

This conclusion was strong in my mind about the time, as far as I remember, when I wrote the "Origin of Species," and it is since that time that it has very gradually grown weaker. But then arises the doubt, can the mind of man, which as I fully believe, has

[1] *The Origin of Species*, 6th Edition, 1885, p. 429.
[2] *Life and Letters*, I, 313.

been developed from a mind as low as that possessed by the lowest animals, be trusted when it draws such grand conclusions?

I cannot pretend to throw the least light on such abstruse problems. The mystery of the beginning of all things is insoluble by us; and I for one must be content to remain an Agnostic.

Thus modestly, thus temperately, without aggressiveness and only for himself, spoke Charles Darwin nearly half-a-century ago. If there be those today or in the future who feel more certain of their knowledge of the truth, let them give utterance to it, ever remembering that one—a master mind—felt it needful in such matters to avoid all aggressiveness and to apologise for touching a matter so abstruse as probably to exceed the present powers of the human mind.

I have told you that I am young enough to have escaped practically the dogmatic teaching in childhood which placed in bondage the minds of the generations preceding Darwin, and Huxley and Galton. But I am old enough to remember the battles of the sixties and seventies, and the joy we young men then felt when we saw that wretched date B.C. 4004, replaced by a long vista of millions of years of development. Just as much as the older men we looked upon Charles Darwin as our deliverer, the man who had given a new meaning to our life and to the world we inhabited. And if you will but study him and interpret the universe by his doctrine you will realise that he is still Darwin, the Liberator, for you also. Yet as you study him for his mind, you will discover that he is not only Darwin the Liberator, and Darwin the Naturalist, but beyond the greatness of his intellect, there is a greatness of character, he is Nature's gracious gentleman[1]. Carlyle forgot to include when he wrote his *Hero Worship*, the 'Hero as Gentleman.' We are happy in being able to admire in our Hero of Science alike his intellect and his character.

If we take this Darwinian creed as stated by Darwin on the last page of the *Origin of Species* more than 60 years ago are there points in which we might venture today to modify it? I would speak with all humility when I say that I think there are. Darwin left open possibilities, which I think more recent research would close. He states that variability arises "from

[1] I only know of one action in Charles Darwin's career, which does not call forth my full sympathy, and of whom can we assert so much? Even in this single case wider knowledge might solve my difficulty, but I have so far sought in vain for a clue.

the indirect and direct action of the conditions of life and from use and disuse."

Now some variation does and can arise without any variation in the conditions of life. The two dogs I now show you were born in one litter of the same two parents. Their variation from one another can only be due to one source—the germ-plasm in the reproductive cells of their parents was not homogeneous. But if variations so great as these are possible, is it not adequate to suppose the bulk of variation to arise from heterogeneity in the reproductive germs? Darwin thought that environmental conditions would modify an organ and that these modifications could be transmitted to their offspring. I feel sure that no environmental changes could make one of those dogs resemble the other, that heterogeneity of germ-plasm carried by either parent is far more influential in producing variation than any direct or indirect effect of the conditions of life. There would be nothing surprising, however, in two dogs like Chang having offspring like Topsy or two dogs like Topsy having offspring like Chang. For the heterogeneity lies not in their bodily characters, but in their germ cells. The great truths that we have learnt since Darwin's are:

(i) that the chief source of variation lies in the heterogeneity of the germ-plasm of the individual;

(ii) that the bodily characters of an individual are not a complete index to his germ-plasm, but only a general indication of it;

(iii) that an individual is only the bearer of the germ-plasm of his stock or stirp, he does not create it, nor is it substantially modified by his life or environment.

The child is like his parent, not because he is the product of his parent, but because his parent and he, partially, are products of the same germ-plasm, which both his parent and his grandparent have handed on. This continuity of the germ-plasm was first insisted on by Francis Galton, who in 1872 announced for the first time the true relation of parent to child, and gave a very deep extension to the Darwinian doctrine. The continuity of the germ-plasm, the fact that the transient individual is only a conduit pipe—so to speak—for the eternal germ-plasm the non-perishing source of life, involves the unity of all life. The germ-plasm which finds its place in our reproductive cells has passed through millions

of years of selection, indirect selection by the destruction of those bearers of it with unsuitable bodily characters—i.e. the Darwinian natural selection,—and direct selection at the reproduction of each new individual—i.e. the Galtonian germinal selection, which produces the phenomena of variation. But the germ-plasma of all living things is and has been through the millions of years of evolution a unity, constantly differentiated in its heterogeneity and as constantly recombined. As one perishable generation hands down its germ-plasm to the next, so each age of living forms has handed on the torch of life to its successor, the age of invertebrates handed its germ-plasm to the age of fishes; the age of fishes to that of amphibia, and the age of amphibia to that of reptiles, and thence it came to the age of mammals. It is a strange but, I think, true conception that while we as individuals perish, we carry with us perpetually multiplying cells which have passed through all the lower forms of life!

A crude analogy might be taken from a tree, representing the germ-plasm as the sap, the branches as genera, the twigs as species and the leaves and flowers as perishing individuals. The leaves and flowers were they capable of sensation might feel themselves the essential units. But they are not, they perish, and the tree as a whole lives on putting forth new branches, new twigs and fresh leaves. It is the real unity, a unity far beyond the comprehension of the individual leaves. So it comes about that the life of the whole organic world, whose purpose we as ephemeral individuals may fail to understand, continues to develop and expand without regard to the fleeting leaves. We are but parts of that larger whole, whose origin and final purpose are beyond the limited scope of human intelligence.

If the geneticists tell you that they have tried in vain to produce new species by germinal selection, there are two valid answers that can be given to them: the first is that it is difficult if not impossible in the laboratory to reproduce those conditions of duration and intensity of physical stress under which it is highly probable that species originated, and the second is: that life is no longer young; our tree is adult, it can no more put forth twigs, much less branches, only individual leaves, and leaves do not produce twigs. In other words the fundamental germ-plasm is now so differentiated, that no further species formation is possible; that was only possible in the heterogeneity of its youth. That the

geneticists have not yet produced a new species does not seem to me a valid argument against Darwinism, unless we assume that the production of new species must ever be going on whatever stage the total of living forms has reached. The stages in the life-history of the universal germ-plasm in which differentiation could produce markedly different new forms may be long past. At any rate experiment in this sense should begin with low and little specialised forms—certainly not mammals. It would be absurd to suppose that very specialised man could be obtained from the very specialised apes known to us. But that both might be obtained from a far less specialised primate is not an unreasonable supposition. We are far from having found that ancestral primate as yet, but since Darwin's day our knowledge of the history of man has immensely increased, and we know something of his form and his tools for at least 100,000 years. That knowledge does not run contrary to Darwin's views. We have not yet reached the common link, but what has been found carries us back both in skeleton and form of brain nearer and nearer to a possible common ancestor. The fossil of such a being, which we should fail to classify as either ape or man might be found any day now, and if found would certainly not create the astonishment today that it would have done 50 years ago, because the gap to be filled would be far less. Meanwhile excavators amuse themselves with such modernities as Tutankhamen, when within a relatively few miles of his tomb, at Fayûm, they might conceivably discover what would be many thousand times of greater scientific importance.

It is time, however, that I concluded this brief survey of what Darwin did for his generation and what he has done for all time. He broke down a barrier and let the waters of scientific inquiry flow out upon as wide and as arid a land as Newton fertilised. To us as everyday men and not zoologists or botanists or anthropologists by profession, he opened up all the vistas of the ages. We look back through hundreds of thousands of years of growth in living forms, where we were pulled up at a few thousands by a dogmatic beginning of all things. And what have we lost? Not necessarily the idea of an ultimate First Cause, but of a First Cause, which produced in a way unintelligible to us, a multitude of living forms all especially provided with, not only the instinct, but the means of killing each other, a creator who for some inexplicable reason charged the rocks with fossils and produced enormous

reptiles in a world just like our own, the climate and conditions of which were totally unsuited to them!

Darwin has expressed definitely his belief that "man in the distant future will be a far more perfect creature than he now is"[1]. That belief of Darwin's might almost be spoken of now-a-days as a truth, if we judge from our present knowledge of the history of man for more than 100,000 years, and predict from that experience of the past man's probable future. Evolution has even from the standpoint of anatomist and psychologist worked towards the perfecting of man, as in a certain sense it has worked to the perfecting of most living forms. Evolution is compatible with a First Cause, even with a First Cause which had in view the development of more perfect living forms, if by methods that appear to the reason of man amoral if not immoral. But to all such final problems Darwin would and did reply. They are impossible for me to answer. "The safest conclusion seems to me that the whole subject is beyond the scope of man's intellect, but man can do his duty"[2].

What did Darwin mean by "man doing his duty"? I think we can interpret the phrase by his own doctrine. Man is governed primarily by heredity and by the facts of variation. Nature has driven him harshly forward on the path towards being a more perfect creature, by the extermination of the physically and mentally less fit. Is it not the duty of man to accelerate Nature's progress? For if there be that First Cause, which gave natural laws to the universe for its development, then these indicate the purpose of its creator, and the interests as well as the duty of man are to hasten the processes of evolution. As Galton, Darwin's cousin said, it is the *religious* duty of man to see that man is better and better born. But that is another story and is an inference, not the moral drawn by Darwin himself from his doctrine. His task lay in breaking our fetters, in producing a revolution in or a reversal of human thought. It is ours to enjoy the immense fields he opened to human inquiry and to study not only the bearing of his teaching on our religious beliefs, but no less its deep significance for our moral judgments. To me it seems that the day is ripe for the application of Darwin's doctrines not only to individual conduct, but to the solution of grave social and political problems.

[1] *Life and Letters*, I, 312. [2] *Ibid.* 307.

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